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Pioneer Venus

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NASA
National Aeronautics and
Space Administration

NOTE TO EDITORS: This fact sheet outlines the mission and basic scientific rationale for Pioneer Venus '78. It is suggested that it be retained in your files for future reference.

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RELEASE NO: 76-53

PIONEER VENUS 1978

SUMMARY

NASA will send both an orbiter and a multiprobe spacecraft to Venus in 1978 to conduct a detailed scientific examination of the planet's atmosphere and weather. The information they gather may help us learn more about the forces that drive the weather on our own planet.

The orbiter will be launched in May and inserted into Venusian orbit in December; the multiprobe spacecraft will be launched in August and the probes will enter the Venusian atmosphere six days after arrival of the orbiter.

The spin-stabilized multiprobe spacecraft consists of a bus, a large probe, and three identical small probes, each carrying a complement of scientific instruments. The probes will be released from the bus 20 days prior to arrival at Venus.

The large probe will conduct a detailed sounding of the lower atmosphere, obtaining measurements of the clouds, the atmospheric structure, and the atmospheric composition. Primary emphasis is on the planet's energy balance and clouds. Wind speed will also be measured during the descent.

- more -

The three small probes, entering at points widely separated from each other, will provide information on the general circulation pattern of the lower atmosphere. Since the important motions are believed to be global, only a few observations are required. The probe bus will provide data on the Venusian upper atmosphere and ionosphere down to an altitude of about 120 kilometers (75 miles) where it will burn up.

The orbiter mission is designed to globally map the Venusian atmosphere by remote sensing and radio occultation, and directly measure the upper atmosphere, ionosphere, and the solar wind/ionosphere interaction. Thus, in combination with measurements made at lower altitudes by the large and small probes and the probe bus, Pioneer Venus will provide a detailed characterization of the entire Venus atmosphere.

In addition, the orbiter will study the planetary surface by remote sensing, utilizing radar mapping techniques. This should provide important information on Venus cratering and surface structure and an estimate of global shape.

The orbiter will be placed in a highly inclined elliptical orbit with the lowest point in Venusian mid-latitudes at about 200 km (120 mi.) altitude. Operation in orbit should allow investigation over at least one Venusian year (225 Earth days).

WHY PIONEER VENUS?

Venus Holds Clues to Earth's Weather. When two Pioneer spacecraft arrive at Venus in 1978 to probe that planet's murky atmosphere, the information they gather may also help us learn more about planet Earth.

NASA believes the study of weather patterns on other planets--and on Venus in particular--can provide clues to the mysteries of our own weather system.

On Earth, the basic causes of weather patterns are not clearly understood, as evidenced by the shifting tornado and hurricane paths that catch communities unaware every year.

Many factors complicate Earth's meteorology. Mixing of oceanic and continental air masses, partial cloud cover, axial tilt, and rapid planet rotation make our atmosphere difficult to study.

But Venus is simpler to study because it has a basic atmosphere that is 95 per cent carbon dioxide, a very slow rotation (243 Earth days equal one rotation of Venus), very little tilt to its axis and no oceans.

If scientists can understand how these variables affect the atmosphere of our closest planetary neighbor, they hope to be able to define more clearly the impact of the numerous variables in the Earth's weather system.

Further insights into basic weather processes will come not only from intensive observations of the Earth itself but also through NASA's current first-hand studies of Jupiter's fast-spinning atmosphere and Mars' easily-observed, largely cloudless atmosphere which is sometimes rendered so opaque by very large dust storms that the surface can no longer be seen.

<u>Questions Important to Man</u>. Comparison of Venus' atmospheric characteristics with those of Earth may help answer other important scientific questions. Among these are:

- Why have the other terrestrial planets taken different evolutionary paths than the Earth's? Spacecraft to Mars and Venus so far have provided only hints to the answer.

- What are the stabilizing and destabilizing feedback mechanisms that determine a planet's climate?

- Did liquid water ever flow on the surface of Mars?

- Where is the water that may have been on Venus originally?

- more -

THE MISSION

Pioneer Venus is the first United States mission developed specifically to investigate directly the atmosphere of Venus on a planetary scale. The two-spacecraft mission consists of an orbiter and a multiprobe spacecraft, to be launched in May and August of 1978. Both spacecraft will arrive at Venus in December of the same year, with the orbiter scheduled to arrive five days before the probe-carrying spacecraft.

To accomplish this timing, the orbiter will be launched on a trajectory which will take it more than 180 degrees around the solar system in eight months. The probe vehicle's trajectory will be a direct path from the Earth to Venus requiring only four months.

The orbiter, carrying 43 kilograms (95 pounds) of instruments, is designed to study the Venusian atmosphere over one 243-day period. The orbiter's elliptical orbit will bring the spacecraft to within 200 km (125 mi.) of the surface, with a maximum distance from the planet set at 60,000 km (37,300 mi.). Most of the data-gathering will occur when the craft is closest to the planet, about one hour per day.

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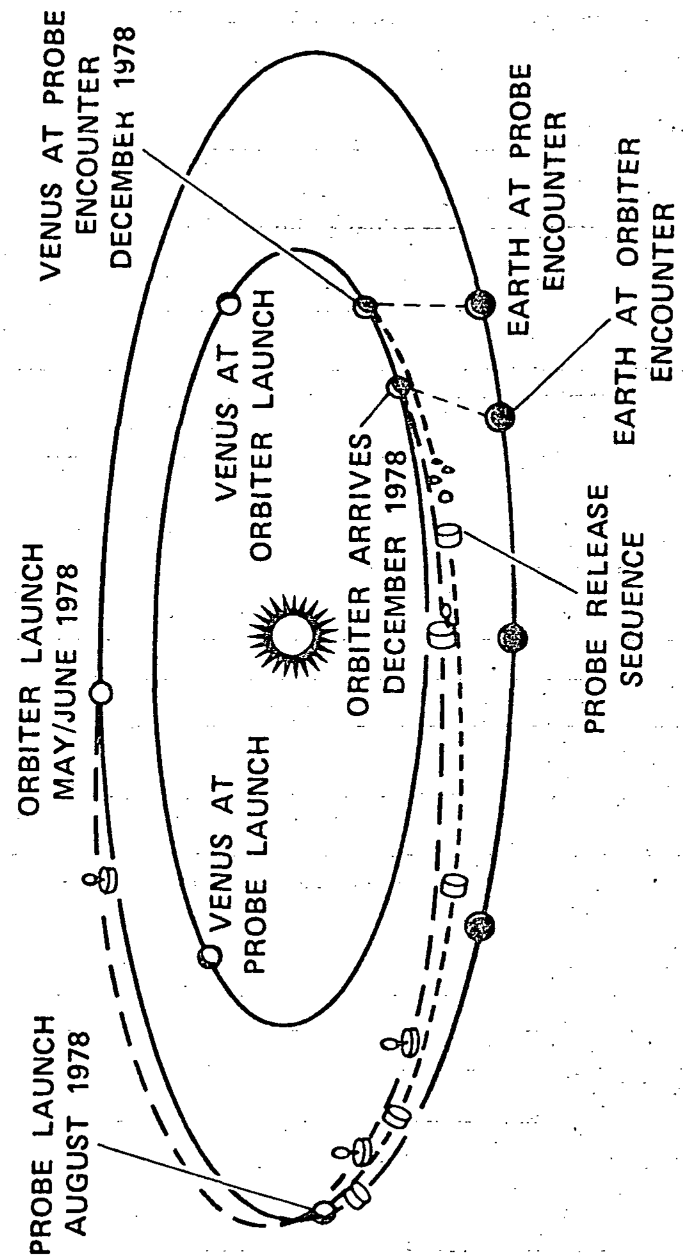
VENUS AT PROBE ENCOUNTER DECEMBER 1978
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PROBE RELEASE SEQUENCE
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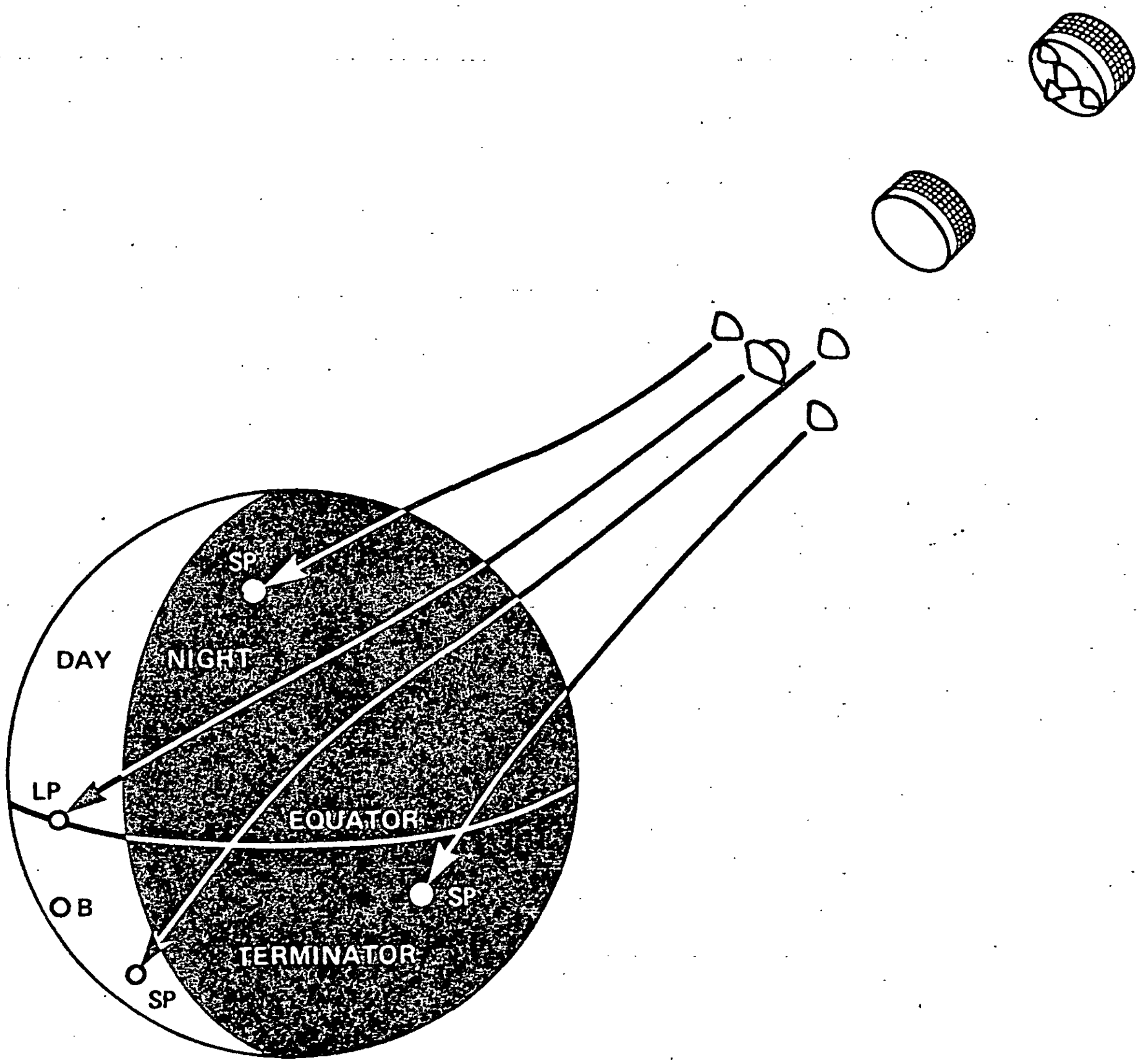
VENUS AT PROBE LAUNCH
PROBE LAUNCH AUGUST 1978



TYPICAL ENTRY POINTS FOR PIONEER-VENUS ATMOSPHERE PROBES

The second spacecraft will carry four separate probes which will be released from this "bus" about 20 days before penetration of the atmosphere. The probes will be targeted to different locations on the planet's surface and tracked during the 70-minute descent through the atmosphere to give valuable information on winds and circulation patterns. The probes will not be designed to survive after impact.

Three of the four probes are small, weighing about 86 kg (189 lbs.) each, including 2.7 kg (6 lbs.) of science instruments. The probes' heat shields and pressure vessels comprise most of the weight. The probes will measure atmospheric pressure and temperature. A nephelometer developed at NASA's Ames Research Center, Mountain View, Calif., will measure cloud extent and altitude and look at changes in cloud densities. A net flux radiometer will also be on board to investigate the exchange of heat energy between the Sun and the atmosphere.

The fourth probe is larger, carrying about 28 kg (62 lbs.) of instrumentation as part of its 291-kg (642-lb.) bulk. Its payload include a mass spectrometer and a gas chromatograph to provide details about the identity of components in the atmosphere.

The bus will also carry a mass spectrometer for studies of the upper atmosphere. After the probe release, the bus will be targeted for a shallow atmospheric entry, obtaining measurements of the upper atmosphere until it burns up at an altitude of about 120 km (75 mi.).

In spite of the mission's ambitious scientific objectives, Pioneer Venus has been carefully designed to be a low-cost project. Much of the planned equipment has already been flown on previous missions, cutting the expense in areas of instrument design and testing. The heavy use of standardized subsystems will allow Pioneer Venus engineers to eliminate much prototype testing.

Commonality is another money saver in this mission. Seventy per cent of the hardware which will go into the main body of the probe-carrying craft is identical with that of the orbiter.

The Pioneer Venus mission is managed for NASA's Office of Space Science by the Ames Research Center, Mountain View, Calif. Spacecraft are built by Hughes Aircraft Company, El Segundo, Calif.

SCIENTIFIC INSTRUMENTS

Multiprobe Mission

Large Probe	
Neutral Mass Spectrometer	John Hoffman University of Texas
Gas Chromatograph	Vance Oyama NASA/ARC
Atmosphere Structure	Alvin Seiff NASA/ARC
Solar Flux Radiometer	Martin Tomasko University of Arizona
Infrared Radiometer	Robert Boese NASA/ARC
Cloud Particle Size Spectrometer	Robert Knollenberg Particle Measuring System
Nephelometer (Cloud Sensor)	Boris Ragent NASA/ARC and Jacques Blamont, University of Paris
Small Probes (3)	
Atmosphere Structure	Alvin Seiff NASA/ARC
Nephelometer	Boris Ragent NASA/ARC and Jacques Blamont, University of Paris
Net Flux Radiometer	Verner Suomi University of Wisconsin
Bus	
Neutral Mass Spectrometer	Ulf von Zahn University of Bonn, West Germany
Ion Mass Spectrometer	Harry Taylor NASA/GSFC

Orbiter Mission

Neutral Mass Spectrometer	Hasso Niemann NASA/GSFC
Ion Mass Spectrometer	Harry Taylor NASA/GSFC
Retarding Potential Analyzer	William Knudsen Lockheed Missile and Space Co.
Electron Temperature Probe	Larry Brace NASA/GSFC
Ultraviolet Spectrometer	Alan Stewart University of Colorado
Solar Wind/Plasma Analyzer	John Wolfe NASA/ARC
Magnetometer	Christopher Russell University of California, Los Angeles
Infrared Radiometer	F. H. Taylor JPL
Cloud Photopolarimeter	James Hansen Goddard Institute of Space Studies
Radar Altimeter	Team*
Electric Field Detector	F. L. Scarf TRW Inc.
Gamma Ray Burst Detector	W. D. Evans Los Alamos Scientific Laboratory

*Radar Altimeter Team Members: G. Counselman MIT, Team Leader; G. H. Pettengill, MIT; W. H. Kaula, UCLA; Harold Masursky; U.S. Geological Survey, and G. E. McGill, University of Massachusetts.

Interdisciplinary Scientists. Interdisciplinary scientists have been selected for both the Multiprobe and Orbiter Missions to provide assistance in analyses of the Venusian atmosphere. They are:

Dr. Siegfried Bauer	NASA/GSFC
Dr. Thomas M. Donahue	University of Michigan
Dr. Richard M. Goody	Harvard University
Dr. Donald M. Hunten	Kitt Peak National Observatory
Dr. James B. Pollack	NASA/ARC
Dr. William Spencer	NASA/GSFC
Dr. Gerald Schubert	University of California, Los Angeles
Dr. Harold Masursky	U.S. Geological Survey
Dr. G. McGill	University of Massachusetts
Dr. Andrew F. Nagy	University of Michigan

Radar and Radio Science

The radio communications system can be used as a scientific instrument by measuring the alterations of the radio signals caused by the planet and its atmosphere. As the radio signal passes through the atmosphere, the signal is changed and observation of the type of change will help characterize the atmosphere. The radio system will be used to determine atmosphere composition and density, cloud locations, wind velocities and atmospheric turbulence.

Radio science experiments will be performed by both the orbiter and the multiprobe spacecraft. On the multiprobe mission, radio science experiments will be performed using all entry vehicles and their associated S-band telemetry systems. Each entry vehicle transmits directly to Earth. Transponder links are provided on the bus and large probe and stable oscillators on each small probe. On the orbiter, five radio science experiments will be performed, using the S-band telemetry system and a specially provided X-band beacon system. (See Scientific Investigations for detailed description.)

SCIENTIFIC INVESTIGATIONS

Multiprobe Mission

Large Probe

Atmospheric Composition Mass Spectrometer The objective of the large probe neutral mass spectrometer investigation is to provide a direct measurement of atomospheric composition and vertical structure in the lower 60 kilometers (36 miles) of the Venus atmosphere. Specifically, the instrument will provide data which will permit determination of the relative abundances and vertical distributions of noncorrosive gases, determination of composition, scale size and physio-chemical properties of the cloud layers; identification of chemically active constituents; determination of the isotopic ratios of chemically inert gases, and determination of crustal abundances of volatile elements.

Atmospheric Composition Gas Chromatograph Analysis The composition of the lower atmosphere of Venus will be measured for the purposes of (a) finding the major gaseous sources of infrared opacity and in this way contribute to the understanding of the existence of the very high surface

temperature; (b) inferring the composition of condensate cloud layers; (c) obtaining information about the degree of differentiation of the interior of Venus from measurements of the level of gaseous radioactive decay products; (d) deducing the degree of similarity between the Venus and Earth solid bodies from the abundance of sulfur compounds; and (e) inferring how Venus' atmosphere evolved.

Cloud Particle Size Spectrometer The particle size and number density in the clouds and lower atmosphere of Venus will be measured, after atmospheric entry, starting at about 66 km (45 mi.) and continuing to the surface. This information should accurately define the levels of cloud cover. Specific information as to mean particle size and mass, along with integrated cloud characteristics such as cloud particle mass content, optical depth and spectral properties, should provide clues to the nature of basic cloud formation processes.

Solar Radiometer The deposition of solar energy will be measured as a function of depth in the atmosphere of Venus. Information on the vertical cloud structure will be obtained and possibly information on the single scattering properties of the cloud particles.

Infrared Radiometer This experiment is designed to determine the magnitude of the divergence of the thermal flux in order to define heat sources and sinks, to detect the location of cloud layers and infer their composition, to determine the importance of clouds in supplying opacity in the infrared spectral region and to obtain an estimate of the abundance of water vapor in the lower atmosphere.

Large and Small Probes

Atmosphere Structure The comparative thermal structure of the atmosphere at four widely separated entry locations on Venus will be measured by instruments on the large probe and the three small probes, over a range extending from the surface to approximately 200 km (120 mi.). Instruments will also measure temperature as a function of pressure with sufficient precision to permit the role of circulation to be assessed in respect to the key question of the Venus

lower atmosphere--how is the high temperature maintained? The experiment is also designed to determine temperature and density at the altitudes of the cloud layers and to measure vertical flow velocities in the lower atmosphere, and the scale and intensity of turbulence.

Nephelometer. The vertical structure of the clouds of Venus will be explored to provide evidence for the existence or absence of particulates (solid or liquid) in the region of about 68 km (40 mi.) to the ground. Since it is is expected that particles will be found to be distributed in layers, placing the instrument on all probes will help to determine whether the stratification is planetary in nature or varies from location to location. In addition, background solar scattered light will be monitored at two wave lengths, at approximately 3500 Angstroms and 5300 Angstroms, by the probes descending in the sunlit side with a vertical spatial resolution of better than 150 mi. (500 ft.).

Small Probe

Net Flux Radiometer. The structure and motions of the atmosphere are fundamentally linked with radiative interchange within it but our present knowledge of radiative heating and cooling in the atmosphere of Venus is inadequate. The primary objectives of the experiment are:

(1) to determine the global and vertical distribution of sources and sinks of radiative energy within the atmosphere and at the surface of Venus and (2) to relate these results to observed atmospheric motions, temperature structure and cloud characteristics.

Bus

Upper Atmosphere Mass Spectrometer The densities of the various atmospheric constituents and their altitude dependence will be measured in the region from 140 km (85 mi.) to about 2000 km (1200 mi.). The experiment will emphasize in situ investigations in the altitude range which can be reached neither by the entry probes nor the orbiter. In addition, the density measurements will be used to derive scale height temperatures from the measured helium distribution, determine the height of the turbopause, deduce approximate eddy diffusion coefficients and determine the relative atmospheric composition at the ionospheric peak.

Ion Mass Spectrometer Measurements will be made of the distribution and concentration of ionic constituents in the upper atmosphere of Venus. These measurements are essential to our understanding of physical and chemical processes governing the behavior of the Venus ionosphere and its interaction with the solar wind.

Radio Science

Differential Very-Long-Baseline Interferometry (DVLBI) Vector wind velocities will be measured during the descents of all four Venus probes, using ground based radio-interferometric tracking. These results will be combined with simultaneous temperature, pressure, heat flux and composition measurements to test models of the atmospheric circulation.

Doppler Tracking Wind Speeds The objective of this experiment is to estimate the wind speeds in the Venus atmosphere from Doppler observations of the probe telemetry carriers. These data will be compared with the results obtained from the DVLBI experiment.

Atmospheric Attenuation The basic objective is to determine the atmospheric structure of Venus as it affects the intensity and refraction of probe telemetry signals. An investigation of the interference between the direct ray and a surface-reflected component will also be undertaken as a means of assessing communications reliability for the design of future probe missions.

Atmospheric Turbulence The objective of this experiment is to measure and study the small scale turbulence characteristics of the Venus atmosphere. Information

obtained will include the variation of intensity of turbulence with altitude, wind velocity transverse to the line-of-sight path and distribution of scale sizes in the atmosphere. These measurements will contribute to our understanding of the atmosphere's circulation and dynamics.

Orbiter Mission

Neutral Particle Mass Spectrometer. The densities of neutral particles in the upper atmosphere of Venus will be measured from approximately 150 km (90 mi.) at periapsis to 500 km (300 mi.) above the surface. Vertical and horizontal variations of the neutral components will be determined which will help to define the existing dynamic chemical and thermal state of the upper atmosphere. Surface height temperatures will be derived from the altitude variations of the measured constituents. The vertical distribution measurement of the light constituents will also help to describe the prevalent gas escape mechanism. The height of the turbopause will be determined by comparing the density distribution of the inert gases with similar measurements made by the mass spectrometer experiment on the large entry probe.

Charged Particle Mass Spectrometer Measurements will be made of the distribution and concentration of ionic constituents in the upper atmosphere of Venus. These measurements are essential to our understanding of physical and chemical processes governing the behavior of the Venus ionosphere and its interaction with the solar wind.

Thermal Electron Temperature Langmuir Probe The primary objective of this experiment is to provide measurements of the thermal structure of the ionosphere of Venus so that an understanding may be gained of the processes by which it is heated and cooled. These processes probably include heating at higher altitudes by interaction with the solar wind and heating at lower altitudes by solar ultraviolet. Information on the electron concentration, ion mass and spacecraft potential also will be derived.

Charged Particle Retarding Potential Analyzer The objectives of this experiment are to determine the main sources of energy input to the ionosphere, the dominant plasma transport processes and the solar wind-ionosphere interaction processes, by measuring temperatures and concentrations of the most abundant ions, the ion drift velocity, electron concentration and temperature and energy distribution of ambient photoelectrons.

Airglow Ultraviolet Spectrometer Characteristics of the thermosphere will be investigated, including temperature, energy balance, the distribution and escape rate of atomic hydrogen in the thermosphere and exosphere, the ultraviolet scattering properties of the cloud tops, hazes, and adjacent atmosphere and the spectral nature, distribution and movement of the ultraviolet albedo features.

Temperature Sounding Infrared Radiometer The objectives of this experiment are to obtain vertical temperature profiles in the upper atmosphere of Venus, from the dense cloud tops to the thermosphere; horizontal temperature gradients in the atmosphere at seven different pressure levels, from about 250 millibars to about 10^{-6} millibars, and so uncover the extent of the four-day circulation and its driving forces; and an accurate net bond albedo for Venus. In addition, a study of the morphology and spectral properties of the uppermost cloud layers and their global variability will be conducted and the local and global energy budget, its diurnal and latitudinal variations and correlation with the ultraviolet markings, if any, will be investigated. The column abundance and vertical distribution of water vapor above the dense clouds will be estimated.

<u>Cloud Photopolarimeter/Imaging</u> The properties and distribution of cloud and haze particles in and above the visible clouds for many locations on the planet will be determined, ultraviolet atmospheric markings and circulation will be observed and the apparent cloud motions will be measured.

<u>Magnetic Field Fluxgate Magnetometer</u> The objectives of this experiment include: measuring the planetary magnetic field and any surface correlated fields, deducing the location and strength of ionospheric current systems, determining the energy and mass balance of the upper atmosphere and investigating the nature of the solar wind interaction with the planet Venus.

<u>Solar Wind Plasma Analyzer</u> The purpose of this experiment is to measure the properties of the solar wind and its interaction with the planet Venus. Specific characteristics such as bulk velocity, flow direction, flux and temperature will be determined from the detailed measurements.

<u>Electric Field</u>. The electric field experiment is designed to provide significant information on the mode of plasma interaction between the solar wind and the exospheric or ionospheric plasma; the variable locations of the Venus bow shock, ionopause and wake cavity boundary; the

role of plasma instabilities in modifying the heat flux from the solar wind to the ionosphere, the wave-particle interaction mechanisms that can cause "pickup" or thermalization of upstream ions, formed when atoms from the Venus exosphere are ionized in the solar wind; the extent of the upstream turbulence region, and the effects of wave-particle interactions within the Venus ionosphere. Secondary objectives involve a search for electromagnetic noise bursts from the atmosphere and analysis of solar wind disturbances at the Venus orbit and in cruise.

Surface Radar Mapping. The Radar Mapping experiment will provide the only direct observations of the surface of Venus to be obtained from the orbiter. The observations may be used to derive the absolute surface heights along the suborbital track to an accuracy of about 100 m (330 ft.) or better and from these an estimate of global shape; the dielectric constant and mean surface undulation (i.e. small-scale slopes) for areas lying along the suborbital track; the surface emissivity and temperature and radar images of selected regions of the surface.

Transient Gamma-Ray Burst. The purpose of the gamma-ray burst experiment is to provide observations of intense,

short duration emissions of high energy photons from astronomical sources. The discovery of this phenomenon is very recent (1973) and the nature and location of the sources are still unknown. By correlating the time of arrival of the gamma bursts at widely separated detectors, it is possible to derive precise information on source direction. The Venus orbiter spacecraft provides an experiment platform separated from the Earth by 1 astronomical unit. Correlations with near-Earth observations can provide directional determinations with accuracies less than one arc minute - sufficient for a meaningful attempt at optical identification of the sources.

<u>Dual Frequency Radio Occultation</u> From the analysis of phase perturbations of the S and X-band telemetry carriers during occultation, refractivity profiles in the lower atmosphere of Venus will be determined. These profiles yield temperatures, pressures, and densities in the neutral atmosphere above about 35 km (20 mi.). In addition, data will be obtained on possible radio absorptive layers below 50 km (31 mi.) in the lower atmosphere, on pressure and temperature gradients and density variations also in the lower atmosphere.

Atmospheric and Solar Corona Turbulence The primary objective of this experiment is to observe and interpret the small-scale turbulence characteristics of the Venus atmosphere above 35 km (20 mi.). The intensity variation of turbulence with altitude, planetary latitude and longitude, and the distribution of scale sizes in the atmosphere will be obtained. These measurements contribute to an understanding of the atmosphere's circulation and dynamics. A secondary objective is to determine the solar corona turbulence and solar wind velocity near the Sun.

Drag Measurements Analysis of satellite drag measurements of the upper atmosphere of Venus, the first such measurements of another planet, should provide data on the density and density scale height of the Venus thermosphere, variations in solar wind in relation to variations in atmospheric density, long and short-term variations in solar extreme ultraviolet radiation in relation to density variations and phenomena such as a semi-annual variation and super rotation of the thermosphere. Based on a comparison of drag measurements and other measurements obtained from the Pioneer Venus orbiter and entry probes' a thermospheric model will be formulated.

Internal Density Distribution The objectives of this investigation are to determine the internal mass distribution and the physical processes that have operated to produce the distribution, the relationship of the surface morphology to the internal density distribution and the amount of isostatic compensation of the Venus topography.

Celestial Mechanics This experiment is designed to model the gravity field of Venus, estimate the direction and magnitude of the Venus spin vector, bound the magnitude of the polar motion of Venus, determine the density profile of the upper atmosphere from observations of orbital decay, improve the planetary ephemerides, especially of Venus and Earth, measure the direct (relativistic) effect of solar gravity on the propagation of the tracking signal and determine a connection between the coordinate system of the planetary ephemerides and an (inertial) coordinate system reference to extragalactic radio sources.

SPACECRAFT

The spacecraft systems, less scientific payloads, are being designed and built by Hughes Aircraft Co. under direction of the Pioneer Project Office at NASA's Ames Research Center. Hughes is also integrating the scientific payload and will test the integrated system and support launch operations.

The design uses existing and proven subsystems wherever feasible. It uses standardized hardware to the maximum extent.

Weight of the two spacecraft and their scientific instruments will be about 567 kg (1250 lbs.) for the orbiter spacecraft and about 885 kg (1950 lbs.) for the multiprobe spacecraft.

Both will be about 250 cm (8 feet) in diameter.

Compatibility with the Deep Space Network (DSN) requires that the communication system use S-band frequencies and both spacecraft will return 2048 data bits per second at Venus. The DSN must track the large probe, three small probes and the bus simultaneously during the planetary entry sequence.

Both orbiter and multiprobe spacecraft systems use a basic bus. In this system, a thermally-controlled equipment compartment is provided, with the bus subsystems mounted internally. For the multiprobe spacecraft version, two scientific instruments also are mounted in this compartment. Also internal are two hydrazine propellant tanks and six nozzles that make up the attitude control system. The attitude control subsystem uses Sun and star sensors to provide attitude reference information. Omni antennas are mounted fore and aft with a medium-gain antenna on the aft side. A cylindrical solar array is mounted on the periphery of the equipment platform.

The Multiprobe Spacecraft

The spacecraft consists of a basic bus modified to include two scientific instruments. It also includes one large probe and three small probes. The spacecraft will be spin-stabilized and solar-powered during interplanetary flight. The bus will perform all trajectory correction maneuvers for targeting the probes.

The large probe and three small probes are each individual spacecraft systems that provide the required subsystems to carry science payloads through atmospheric entry to the surface of Venus, while maintaining direct communication links with Earth-based DSN stations.

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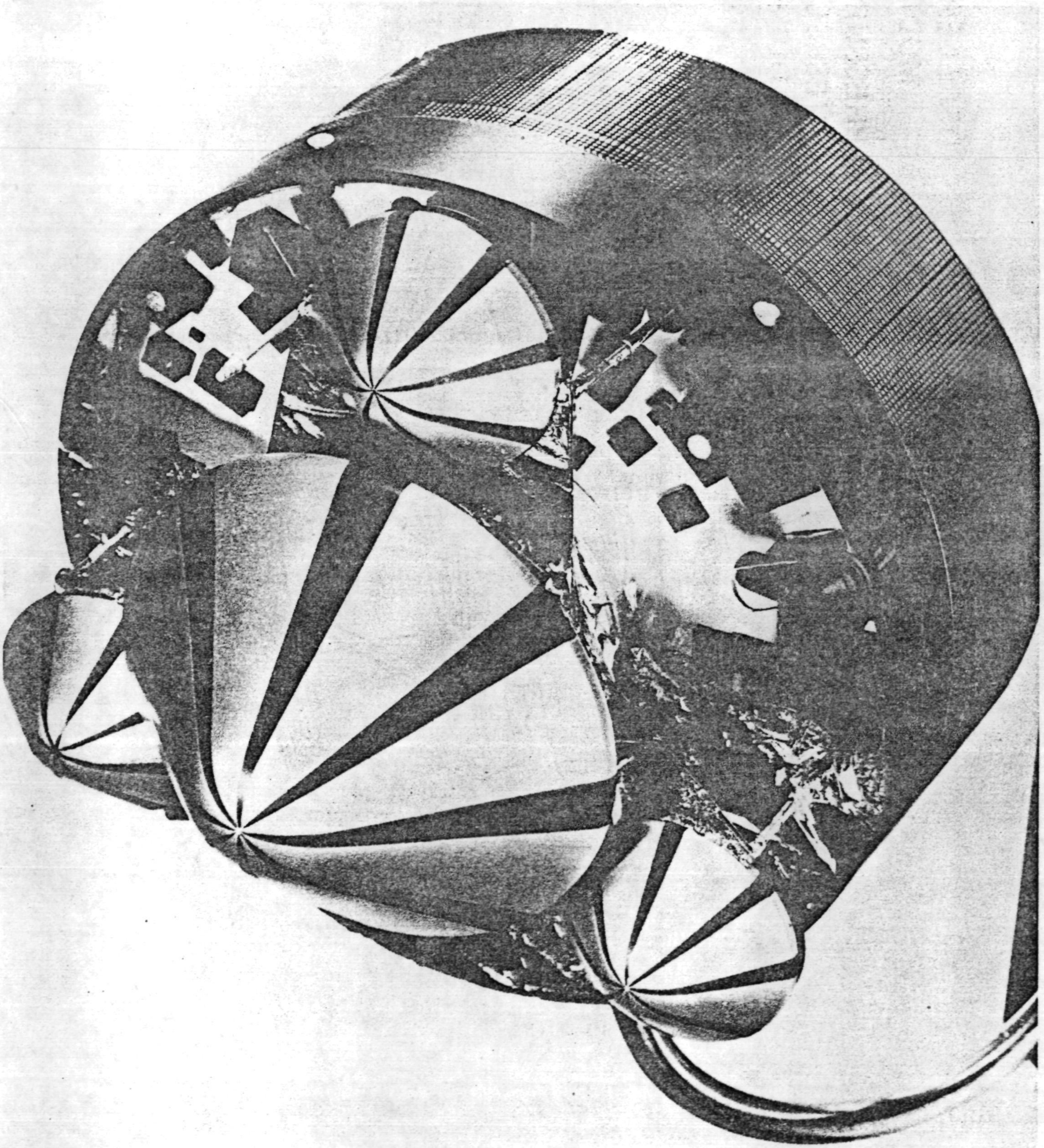
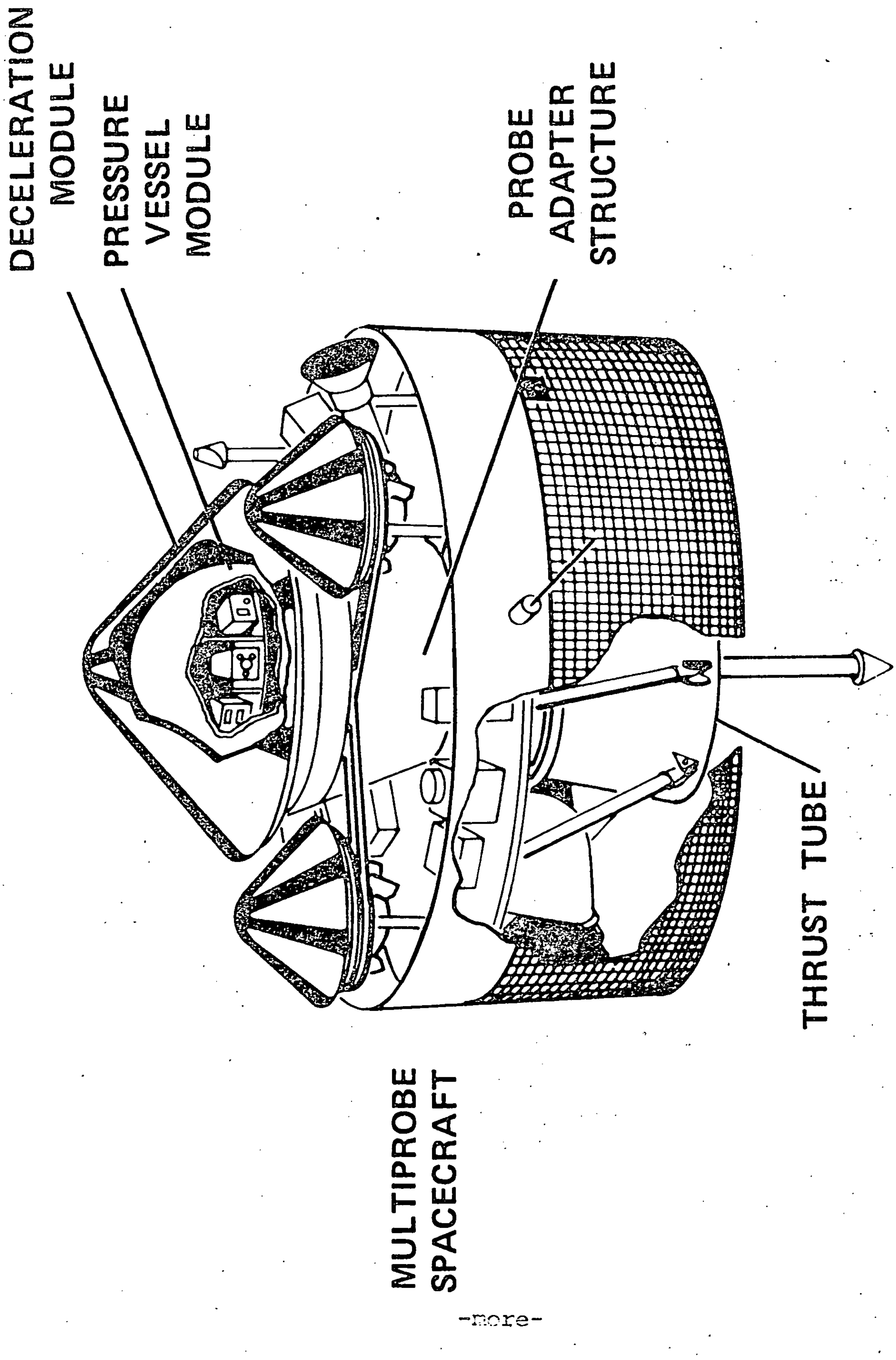


Pioneer Venus Multiprobe Spacecraft


DECELERATION MODULE
PRESSURE VESSEL MODULE
PROBE ADAPTER STRUCTURE
THRUST TUBE
MULTIPROBE SPACECRAFT

<u>The Large Probe</u> The large probe weighs about 291 kg (642 lbs.) and is 145 cm (about 5 ft.) in diameter. It will return data at 256 bits per second and carry 28 kg (62 lbs.) of instruments.

The forward end of the large probe has a carbon phenolic heat shield for heat protection and aerodynamic stability during atmosphere entry and a parachute descent subsystem.

The remaining probe subsystems, data handling, power thermal protection, communications and structure are mounted inside the probe pressure vessel, as is the science payload. The pressure vessel is sealed against the Venusian environment. A single, hemispheric omni-directional antenna is provided on the aft end of the probe pressure vessel.

<u>The Small Probe</u> The small probe configuration is identical for each of the three small probes. Each probe is 71 cm (28 in.) in diameter, weighs 86 kg (189 lbs.), transmits data at 16 to 64 BPS and carries 2.7 kg (16 lbs.) of instruments.

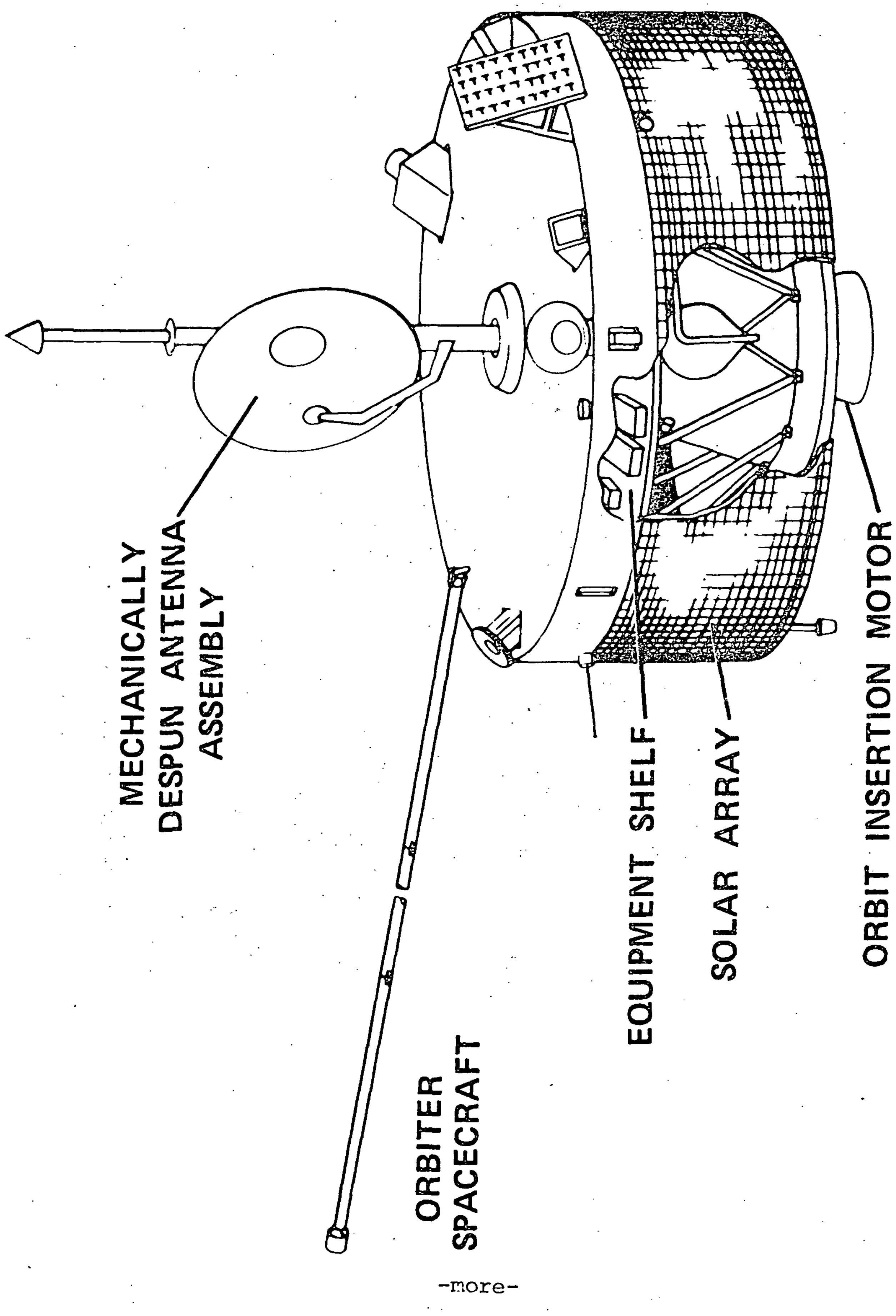
The pressure vessel for the small probes seals the small probe subsystems and the science payload from the hostile Venusian atmosphere. No parachute descent system is used for the free-falling small probes.

The high-speed aerodynamic designs for both the large and small probes are similar with a 45 degree conical forebody (heat shield) used in both designs.

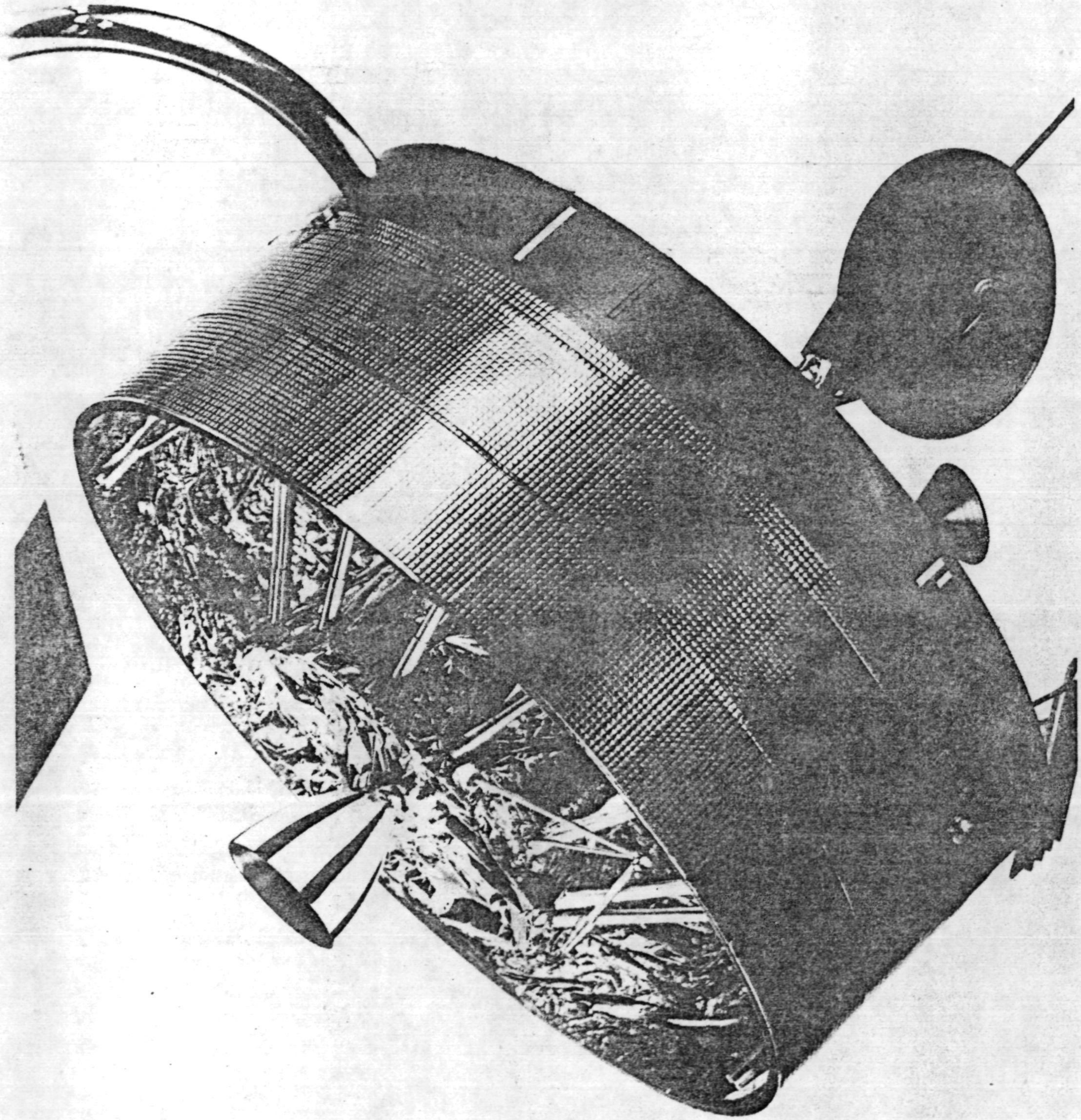
The Orbiter Spacecraft

The orbiter spacecraft system, as with the multiprobe, uses the basic bus. At the forward end of the bus is the bearing and power transfer assembly to mechanically despin the parabolic, high-gain antenna. With the spacecraft spin axis spin-stabilized perpendicular to the ecliptic plane (Earth's orbit plane), the despun, high-gain antenna reflector will be focused on the Earth during its interplanetary phase and throughout its orbital lifetime. An orbit insertion motor will be mounted at the other end of the orbiter spacecraft to place the spacecraft in Venus orbit. A slightly larger solar array will be provided to meet the larger power demand of an orbiting spacecraft. A larger data storage unit also is being provided.

All orbiter spacecraft scientific instruments will be on the equipment platform inside the bus. The magnetometer sensor is mounted at the end of a boom to insure no magnetic interference from the spacecraft.



ORBITER SPACECRAFT



Pioneer Venus Orbiter

TRACKING AND DATA ACQUISITION

Tracking and data acquisition for the multiprobe and orbiter spacecraft will be provided by the NASA Deep Space Network (DSN) operated by NASA's Jet Propulsion Laboratory, Pasadena, Calif. A subnet of deep space stations with 26-meter (85-foot) diameter antenna systems and around-the-world coverage will provide basic tracking support. The 64-m (210-ft.) diameter antenna subnet will provide coverage during critical phases of the mission such as reorientation, velocity corrections and Venus encounter.

GROUND DATA SYSTEM

The ground data system for the Pioneer Venus missions involves facilities of the Deep Space Network, which includes the deep space stations and the network operations facilities at JPL, and the NASA ground communications network and Pioneer mission operations and computing center facilities at Ames Research Center.

LAUNCH VEHICLE

The launch vehicle for the Pioneer Venus mission is the Atlas SLV-3D/Centaur D-1AR vehicle.

The first-stage Atlas is powered by two booster engines, a sustainer engine and two small vernier engines.

The second stage Centaur employs liquid hydrogen and liquid oxygen as propellants. Primary thrust is provided by two engines which gimbal for pitch, yaw and roll control and have a restart capability.

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March 1976